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ABSTRACT. Previous studies have suggested that passive smoking (involuntary inhalation of tobacco smoke by nonsmokers) reduces small airways function. We evaluated the exposure to passive smoking and its effects on pulmonary function and symptoms in a group of 12- to 17-year-old high school athletes (N=209; 119 boys and 90 girls) at their annual presport participation physical examinations. A structured interview was used to assess pulmonary symptoms, personal smoking habits, and passive cigarette smoke exposure. All athletes performed forced expiratory maneuvers on a portable spirometer. We measured forced vital capacity, forced expiratory volume in 1 second, and forced expiratory flow 25% to 75% (FEF25-75). The best of three FEF25-75 measured was used. Less than 70% of predicted FEF25-75 was considered abnormal. Of the 209 athletes, 7.7% were active smokers and were excluded. Of the remaining 193 athletes, 68.4% were currently exposed to passive smoking. We found a fourfold increase in incidence of low FEF25-75 and/or cough in athletes exposed to passive smoking compared with athletes not exposed: 18 of 132 exposed athletes (13.6%) had low FEF25-75 and/or cough compared with two of 61 unexposed athletes (3.3%) who had low FEF25-75 and cough (P=.02). Boys were more frequently exposed to passive smoking than girls (74% of boys [80/108] v 61% of girls [52.85]), but the effects were more pronounced in girls. These data show a relationship between exposure to passive smoking and early pulmonary dysfunction in young athletes. The frequent exposure to passive smoke and the high prevalence of dysfunction in this population, generally considered to be healthy, is of particular concern.

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Reduction in Pulmonary Function and Increased Frequency of Cough Associated With Passive Smoking in Teenage Athletes

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ABSTRACT. Previous studies have suggested that passive smoking (involuntary inhalation of tobacco smoke by nonsmokers) reduces small airways function. We evaluated the exposure to passive smoking and its effects on pulmonary function and symptoms in a group of 12- to 17-year-old high school athletes (N = 209; 119 boys and 90 girls) at their annual presport participation physical examinations. A structured interview was used to assess pulmonary symptoms, personal smoking habits, and passive cigarette smoke exposure. All athletes performed forced expiratory maneuvers on a portable spirometer. We measured forced vital capacity, forced expiratory volume in 1 second, and forced expiratory flow 25% to 75% (FEF_{25-75}). The best of three FEF_{25-75} measured was used. Less than 70% of predicted FEF_{25-75} was considered abnormal. Of the 209 athletes, 7.7% were active smokers and were excluded. Of the remaining 193 athletes, 68.4% were currently exposed to passive smoking. We found a fourfold increase in incidence of low FEF_{25-75} and/or cough in athletes exposed to passive smoking compared with athletes not exposed: 18 of 132 exposed athletes (13.6%) had low FEF_{25-75} and/or cough compared with two of 61 unexposed athletes (3.3%) who had low FEF_{25-75} and cough ($P = .02$). Boys were more frequently exposed to passive smoking than girls (74% of boys [80/108] *v* 61% of girls [52/85]), but the effects were more pronounced in girls. These data show a relationship between exposure to passive smoking and early pulmonary dysfunction in young athletes. The frequent exposure to passive smoke and the high prevalence of dysfunction in this population, generally considered to be healthy, is of particular concern. *Pediatrics* 1987;80:32-36; *passive smoking, cough, spirometry, adolescent, athlete.*

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Passive smoking, or involuntary inhalation of tobacco smoke by a nonsmoker, has been implicated as a threat to health.[1-4] Sidestream smoke arising from the burning end of a cigarette produces approximately two thirds of the air pollution resulting from tobacco smoke in a room.[5] Concentrations of most toxins and carcinogens present in cigarette smoke are higher in sidestream than in exhaled mainstream smoke.[6] Reports of adverse health effects from passive smoking range from increased frequencies of acute and chronic respiratory illnesses in infants and young children to a higher incidence of lung cancer in nonsmoking spouses.[7-14] Recent studies have shown an overall increased cancer risk in passive smokers, with the greatest risk being in adults who have been passive smokers since childhood.[15,16]

In studies of young children, exposure to parental smoking has been associated with a greater frequency of respiratory symptoms such as cough, increased mucous production, and wheezing, as well as an increased incidence of asthma and bronchiolitis.[8,13,14,17] Impaired pulmonary function has been observed in nonsmoking children whose parents smoke, suggesting a reduction of small airways function due to passive smoking early in life.[18-20]

In this study, we evaluated the effects of passive smoking exposure on pulmonary function and

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symptoms in a group of high school athletes. We defined passive smoking exposure as living at home with one or more smokers or being exposed to a friend's cigarette smoke for at least two hours per week.

MATERIALS AND METHODS

In August 1985, during a five-day period, we performed physical examinations on approximately 600 teenage athletes 12 to 17 years of age at five suburban high schools in Nassau County, New York. Because of time constraints in completing the standardized questionnaires and performing pulmonary function testing, we limited the number of athletes sampled to no more than 45 per day. Boys or girls were sampled on alternate days, starting with boys on the first day. A structured interview assessing personal tobacco use, passive smoking exposure, and pulmonary symptoms was given by one of us (M.S.J.). Histories of smoking by all household members and peers were obtained from the athletes. No athlete was currently receiving medication, but several reported a medical diagnosis of a pulmonary condition. Subjects were specifically asked about symptoms of cough, wheezing, or dyspnea during exercise or at rest. Data were analyzed using χ^2 analysis or Fisher exact test. Relative risk is the ratio of the prevalence of abnormal findings in the exposed to unexposed groups.

After the questionnaires and standard physical examinations were completed, the athletes performed forced expiratory maneuvers on a portable spirometer (Devilbiss Surveyor I, Somerset, PA). Daily verification of calibration was done using a precalibrated 3-l Devilbiss surveyor syringe. We measured forced vital capacity, forced expiratory volume in 1 second, and forced expiratory flow at 25% to 75% of vital capacity (FEF_{25-75}). Studies have shown that FEF_{25-75}, which corresponds to expiratory flow when 25% to 75% of forced vital capacity is expired, is the most sensitive of the common spirometric indicators of small airways dysfunction.[21] Less than 70% of predicted FEF_{25-75}, which corresponded to the lower fifth percentile in our study, was considered abnormal. Our intention was to consider the lower 5% of FEF_{25-75} values as abnormal because that level is used extensively as a criteria of an abnormality. All pulmonary function measurements were expressed as percentages of predicted values for age, height, weight, sex, and race using nomograms of Polgar and Promadhat[22] and Knudson et al.[23] The best of three acceptable FEF_{25-75} measures was used for data analysis, allowing a maximum of 5% difference between tests.

RESULTS

A total of 209 athletes were asked and agreed to complete the questionnaire and to undergo pulmonary function testing. Of these, 16 (7.7%) were active smokers or exsmokers and were excluded. Three of the 16 active smokers (19%) had abnormal FEF_{25-75} values and/or cough. Of the remaining 193 nonsmoking athletes, 132 (68.4%) were currently exposed to passive smoking. The specific sources of passive smoke exposure are shown, in descending order, in Table 1. It is evident that exposure to smoking parents accounted for the majority of exposure, but friends also provided a sizeable source of exposure, either alone or in combination with other family members. The characteristics of the currently exposed and unexposed groups of teenage athletes are given in Table 2. The two groups were similar except for sex; 61% of boys were in the exposed group *v* 47% of girls ($P = .04$). The sample size was inadequate to allow grouping of exposure in a way that would permit evaluation of dose-response relationships.

The reported frequency of respiratory conditions and symptoms for both groups is given in Table 3. The frequency of allergies, asthma, bronchitis, shortness of breath, and wheezing was similar in the exposed and unexposed athletes. The frequency

TABLE 1. Sources of Passive Smoke Exposure

Source of Exposure	% of Adolescents
Mother or father	23.5
Mother and father	18.2
Mother or father and friends	14.4
Friends only	11.4
Mother, father, and siblings	6.8
Siblings only	3.0
Other combination of above	22.7

TABLE 2. Characteristics of Currently Exposed and Unexposed Teenage Athletes

Characteristic	Unexposed Athletes (n = 61)	Exposed Athletes (n = 132)
Age (mean yr ± SD)	15.0 ± 1.7	14.7 ± 1.7
Height (mean cm [in] ± SD)	166.1 ± 10.4 [65.4 ± 4.1]	166.4 ± 10.2 [65.5 ± 4.0]
Wt (mean kg [lb] ± SD)	59.0 ± 13.1 [131.1 ± 29.0]	60.8 ± 13.5 [135.0 ± 30.0]
Race (% white)	78.3	88.5
Sex (% boys)	46.7	60.7

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TABLE 3. Respiratory Conditions and Symptoms by History

Condition or Symptom	% of Athletes Exposed to Passive Smoking	% of Athletes Unexposed to Passive Smoking
Allergies	10.0	15.5
Asthma	6.9	6.9
Bronchitis	2.3	5.2
Shortness of breath	5.8	7.1
Wheeze	3.1	3.4
Cough	7.2	1.8

TABLE 4. Athletes with Abnormal Forced Expiratory Flow 25% to 75% (FEF_{25-75})

FEF_{25-75} Value	% of Athletes Exposed to Passive Smoking (n = 132)	% of Athletes Unexposed to Passive Smoking (n = 61)
>70%	92.4	96.7
<70%	7.6	3.3

of cough was four times greater in the group exposed to passive smoking ($P = .08$). The frequency of abnormal FEF_{25-75} values in the exposed and unexposed groups is shown in Table 4. Among exposed athletes, 7.6% had a low FEF_{25-75} value, whereas among unexposed athletes, 3.3% had a low FEF_{25-75} value. This was a 2.3-fold increase in frequency of low FEF_{25-75} values in athletes currently exposed to passive smoking ($P = .21$).

Although cough and abnormal FEF_{25-75} values were each higher in frequency in the exposed than in the nonexposed athletes, the differences, when considered separately, were not statistically significant. When cough and low FEF_{25-75} value were combined, as shown in Table 5, the percentage of athletes with abnormal FEF_{25-75} values and/or a history of cough was 13.6% of the exposed subjects *v* 3.3% of the unexposed athletes, this being a fourfold increase in the frequency of these conditions in exposed athletes, which is a statistically significant difference ($P = .02$). The association between exposure to passive smoking and abnormal FEF_{25-75} value and/or cough was statistically significant for girls ($P = .03$). For boys, the relationship was consistent but not significant ($P = .29$) (Table 5).

DISCUSSION

The data in this study show a relationship between passive smoking and early pulmonary dysfunction and symptoms in young athletes. The high prevalence of passive smoking exposure in this group of athletes who had never smoked (68%) is comparable with other reports.[1,20] Earlier findings reported by Tager and associates,[16,19] although lacking quantitative measurements of passive smoking exposure, showed that cigarette smoking by parents had a measurable effect on decreased pulmonary function in the children independent of any direct use of cigarettes by the children. In their longitudinal study,[19] they showed that the lungs of nonsmoking children whose mothers smoked grew at only 93% of the rate of growth in nonsmoking children with nonsmoking mothers. In adolescence, peers become an increasingly important contributing factor to passive smoking exposure, sometimes being the only source of this exposure, as it was for 11.4% of athletes in this study. A recent study of the effect of passive smoking on children's pulmonary function in Shanghai[24] showed a decrease in pulmonary function that was related to the father's cigarette smoking. All of the mothers denied smoking in that study, and passive smoking exposure from peers was not investigated, an important consideration because 8- to 16-year-old subjects were studied. Nevertheless, the Shanghai study's finding that the effect of passive smoking is greater in school girls than boys was repeated in the present study.

Charlton[13] has shown a link between parental smoking at home and the reporting of frequent coughs by children 8 to 19 years old who had never smoked. Frequent coughs may indicate acute and chronic pulmonary irritation or pathology—a possible result of respiratory tract damage from passive smoking. In this study, we noted a fourfold increase in report of coughs by the athletes exposed to passive smoking. Charlton, surveying 15,709 athletes, showed a dose-response effect of parental smoking on cough, with increasing likelihood of cough being reported depending on whether none, one, or both parents smoked.

When the same investigators question and test subjects, the possibility of interview bias is raised. In this study, the investigators who performed the pulmonary function testing were blinded to questionnaire results. Another possible source of bias is in the child's report of parental smoking. The validity of the self-report method has been verified by Jarvis and associates,[25] who used salivary cotinine levels as a biologic marker of passive smoke exposure in children. Cotinine, a major metabolite of nicotine that is specific to tobacco smoke, appears

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TABLE 5. Athletes With Abnormal Forced Expiratory Flow 25% to 75% (FEF_{25-75}) or Cough by Exposure to Passive Smoking

FEF_{25-75} Value	Both Sexes*		Girls†		Boys‡	
	Exposed	Unexposed	Exposed	Unexposed	Exposed	Unexposed
>70% without cough	114	59	45	32	69	26
<70% or cough	18	2	7	0	11	2

* FEF <70% or cough among exposed (13.6%) *v* unexposed (3.3%); relative risk = 4.1, $P = .02$.
† $P = .03$.
‡ $P = .29$.

to be the marker of choice for quantifying passive exposure to cigarette smoke.[26,27] Jarvis et al found that average concentrations of cotinine in saliva increased in a dose-related fashion; the more sources of exposure the child reported, the higher the level of cotinine in his or her saliva.

CONCLUSION

Our study results are consistent with previous studies showing a relationship between passive smoking and increased frequency of cough and decreased pulmonary function, with girls showing a stronger effect than boys. In addition, among adolescent athletes we found a high prevalence of passive smoke exposure, especially among boys, and a substantial exposure to peers who smoke. Our group of overall healthy, athletic teenagers, a group we would least expect to show manifestations from passive smoking, showed clear evidence of its effects.

As stated in the 1986 American Academy of Pediatrics statement on the hazards of involuntary smoking in children,[28] there is an urgent need for immediate action to reduce passive smoking in children. Pediatricians should be aware of the extent of exposure in their patients, the harmful effects, and the need to consider passive smoking in the differential diagnosis of chronic cough and decreased pulmonary function in adolescents.

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ANOREXIA NERVOSA—SIGNS TO WATCH FOR

Dr. Paul Garfinkel, a psychiatrist with Toronto General Hospital, estimates that severe anorexia nervosa is prevalent in about 1 percent of the female population and mild to moderate anorexia nervosa in about 2 to 3 percent of Americans. The prevalence of bulimia, another eating disorder, is about 10 percent. Garfinkel has listed several early warning signs that should alert physicians to the possibility of anorexia nervosa. These include:

Changing weight goals—"A young woman who reaches her weight-loss goal and immediately sets a subsequent goal could be a prime candidate for anorexia nervosa," Garfinkel says.

Dieting in isolation—Most dieters want to be with other dieters; isolated dieting should be regarded warily.

Dieting and increasing criticism—Most dieters are delighted when they have lost weight. A successful dieter who remains self-critical should be watched, says Garfinkel.

Amenorrhea—The cessation of menses is an early warning sign of anorexia nervosa.

Physicians who see these signs in patients should provide "common-sense" advice and counseling. Also, says Garfinkel, physicians might "avoid doing harm" by not prescribing dieting in patients they think may be at risk for anorexia nervosa.

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